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1 Abstract

We are considering the method of information transfer using 100% spin-polarized electrons.
The novelty of the method lies in the use of two states of entangled electron beams to encode transmitted information - 100% spin-polarized as “1” and arbitrary spin-polarized ones as “0” on the near end.
Because no measurement is made, the wave function of the entangled system remains in a superposition of multiple states and the probabilities of each state remain unchanged. In this case, the Heisenberg uncertainty principle is not violated, as the precise values of the physical properties of the entangled electrons are not determined by measurement.
Mapping to the state of 100% spin-polarized electron beam as “1” and absence of this one as “0” on the near end, we will have the same values in the Stern-Gerlach experiment at the far end.
The relevance of the proposed method lies in the fact that for the first time theoretically shown the possibility of a non-local information transfer. This type of information transfer is independent from the distance between data source and receiver. There is also no time delay and the possibility of intercepting information transmission.
This methodology is not restricted to entangled electrons, but can be extended to encompass a range of other entangled particle systems.
If this method can be experimentally confirmed, it would be a groundbreaking discovery in the field of information transfer.
Keywords: Information transfer, 00% spin-polarized electrons, Heisenberg uncertainty principle, Stern-Gerlach experiment

2 Introduction

It is our pleasure to discuss the method elaborated below, which has been developed using the latest findings reveal that ordinary, unentangled electrons can now be emitted with spin-dependent photoemission properties.

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3 Results

Let's assume we have entangled 100% spin-polarized electrons.
Recent studies have confirmed the possibility of emitting an ordinary (unentangled) such type of electron beam. In the Na_2KSb/Cs_3Sb photocathode, spin-dependent photoemission properties were established through the detection of a high degree of photoluminescence polarization and high polarization of the photoemitted electrons [1].
Ordinary close to 100% spin-polarized electron beams is a crucial concept in quantum mechanics and have various properties that can be described using mathematical equations.
The spin state of an electron can be represented by a vector in three dimensions, with the magnitude of the vector equal to the magnitude of the spin angular momentum $\frac{\hbar}{2}$, where ħ is the reduced Planck constant. The spin state vector can be written as a superposition of two orthogonal states, often denoted as $|+\rangle$ and $|-\rangle$, which represent the two possible orientations of the electron's spin [2].
When a beam of spin-polarized atoms is passed through a magnetic field gradient, the Hamiltonian for the system is given by:

$$H = -\mu \bullet B \bullet S \tag{1}$$

where:
μ – the magnetic moment of the electron;
B – the magnetic field strength;
S – the spin angular momentum operator [3].
This equation shows that the energy of the system depends on the orientation of the spin and the strength of the magnetic field.
If the beam is 100% spin-polarized, meaning that all of the electrons have the same orientation, the Hamiltonian for the system reduces to:

$$H = -\mu \bullet B \bullet m \tag{2}$$

where m is the projection of the spin state vector onto a chosen axis [4].
In this case, there is no net magnetic moment, and the beam will not split into separate components in the Stern-Gerlach experiment. Scientific works of Cartan [5] and Edmonds [6] play a crucial role in understanding the behavior

[1][] Rusetsky, V. A., Golyashov, S. V., Eremeev, V. S. and others: New Spin-Polarized Electron Source Based on Alkali Antimonide Photocathode // Phys. Review Lett. 129, Issue 1614, (October 2022), Article No. 166802

[2][] Zettili, N.: Quantum Mechanics: Concepts and Applications. 3 *d* edition. Wiley, New York (2022)

[3][] Griffiths, D. L., Darrell, F. S.: Introduction to Quantum Mechanics. 3 *d* Edition. Cambridge University Press, Cambridge (2018)

[4][] Ballentine, L. E.: Quantum Mechanics: A Modern Development. 2 *nd* Edition. World Scientific Publishing Company, Singapore (2014)

[5][] Cartan, E.: The Theory of Spinors in Hilbert Space. Dover Publications, New York (1966)

[6][] Edmonds, A. R.: Angular Momentum in Quantum Mechanics. Princeton University Press, Princeton (2016)

of such beams in the above experiment.
In the case of entangled 100% spin-polarized electrons, we must have these electrons' unique properties in the Stern-Gerlach experiment at the far end. Wherein we are avoiding a violation of the Heisenberg uncertainty principle for entangled electrons by not making any measurements at the near end.
The Heisenberg uncertainty principle states that it is impossible to determine simultaneously the precise values of certain pairs of physical properties, such as position and momentum, of a particle with complete accuracy [[7]]. This principle applies to entangled electrons as well, and any measurement made on one of the entangled particles will inevitably affect the state of the other particle.
But in our case the wave function of an entangled system is described by a superposition of multiple states, each corresponding to a different set of values for the physical properties of the particles [[8]]. The wave function can be written as a linear combination of basis states, denoted as $|\psi_i\rangle$, with coefficients c_i:
$|\Psi\rangle = \sum c_i |\psi_i\rangle$ (**??**)
The coefficients c_i determine the probability of each basis state and are given by the square of the magnitude of c_i:
$|c_i|^2 = \mathrm{Prob}(|\psi_i\rangle)$ (**??**)
If no measurement is made, the wave function of the entangled system remains in a superposition of multiple states and the probabilities of each state remain unchanged. In this case, the Heisenberg uncertainty principle is not violated, as the precise values of the physical properties of the entangled electrons are not determined by measurement [3].
Let's mark the entangled 100% spin-polarized electrons state at the near end and the outcome of the Stern-Gerlach experiment at the far end as "1".
Then remove 100% spin-polarization of our electron beam at the near end. Mark this condition as "0".
In the Stern-Gerlach experiment at the far end we will deal with a randomly polarized electron beam, electrons with different spin orientations are passed through a non-uniform magnetic field.
In a randomly polarized electron beam, not all electrons have the same spin orientation, and thus there is a net magnetic moment. As a result, the magnetic field splits the beam into two separate components, each with a different energy state, and the spatial separation of the two components corresponds to the different spin orientations of the electrons [2]. This outcome of the experiment marks "0" at the far end also.
Thus, mapping to the state of 100% spin-polarized electron beam as "1" and absence of this one as "0" on the near end, we will have the same values in the Stern-Gerlach experiment at the far end.
So, we can achieve non-local information transfer.

[7] [[Heisenberg, W.: Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik. Zeitschrift für Physik. 43(3-4), 172-198 (1927)

[8] Dirac, P. A. M.: The principles of quantum mechanics. Clarendon Press., Oxford (1982)

4 Conclusion

The described method of information transfer is independent from the distance between data source and receiver. There is also no time delay and the possibility of intercepting information transmission.

This methodology is not restricted to entangled electrons, but can be extended to encompass a range of other entangled particle systems.

If this method can be experimentally confirmed, it would be a groundbreaking discovery in the field of information transfer.

5 References

[1] Rusetsky, V. A., Golyashov, S. V., Eremeev, V. S. and others: New Spin-Polarized Electron Source Based on Alkali Antimonide Photocathode // Phys. Review Lett. 129, Issue 1614, (October 2022), Article No. 166802

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